

A short guide to National Emerging Technology Policy Strategising (NETS)

Exploring effective practices, tools, and lessons learned for
strategic and systematic analysis of emerging technologies

Centre for Science, Technology & Innovation Policy (CSTI) in collaboration with the Department
for Science, Innovation & Technology (DSIT)

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Executive summary

This document serves as a short guide to strategic analysis of emerging technologies for policy. It summarises a flexible and adaptable process developed in detail in [the Policy Handbook on National Emerging Technology Policy Strategising](#).

Each step of the process and its key supporting frameworks and tools are summarised below. Conceptual underpinnings, templates, use cases and a glossary of key terms are presented in the Handbook.

The Handbook significantly draws on tacit knowledge embedded within UK stakeholders involved in past and current emerging technology policy and analysis, aiming to enable the transfer of insights gained to inform future strategy.

It is based on insights from interviews with key UK policy makers and analysts, other relevant UK stakeholders, and key policy documents. Recommendations are also based on academic research and conceptual frameworks, and international best practice.

Project website: <https://www.ifm.eng.cam.ac.uk/research/cstip/themes/emerging-technology-emtech-policy/nets-national-emerging-technology-policy-strategizing/>

Glossary website: <https://www.ifm.eng.cam.ac.uk/research/cstip/themes/emerging-technology-emtech-policy/glossary-for-emerging-technology-policy-strategising-nets/>

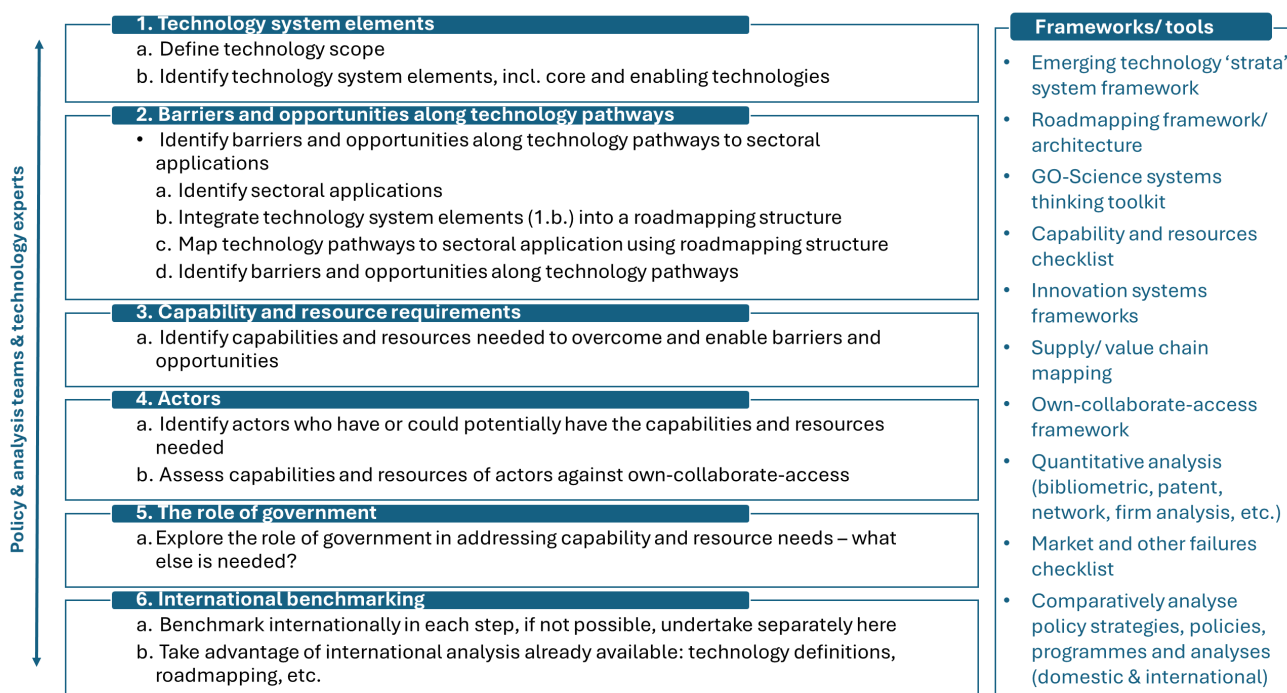
A guide to emerging technology policy analysis

An adaptable six step process is presented for emerging technology policy analysis as shown in Figure 1. Each step and its key supporting frameworks and tools are summarised below. They are further detailed in the Handbook, which also provides example use cases and templates.

Each step of the process can stand on its own or the steps can be sequenced in an order that is most useful for analysis. The sequencing is most likely to depend on the: 1) objective of the strategic analysis, 2) stage of technology development and 3) state of policy and evidence (see below for more detail on this point).

Figure 1 A flexible guide to analysing emerging technology policy.

Sequencing and effort depends on: Objective & Stage of technology development & State of policy and evidence



For each step, scanning the international landscape can help to understand whether there is already existing evidence and analysis that can be used (e.g., technology definitions and hierarchies, technology roadmaps, etc.), especially produced by countries that are at a more advanced stage of strategic analysis. Especially Steps 1-3 may benefit from non-country specific evidence and analysis, while Steps 4-5 may benefit from the knowledge of policymakers undertaking significant consultation with key actors. When further contextualisation and more detail is required, workshops and consultations with well-selected experts and desk-based quantitative and qualitative analyses can be undertaken. If resources allow a mix of the above would enable the most comprehensive coverage of related issues.

Sequencing of the analytical process

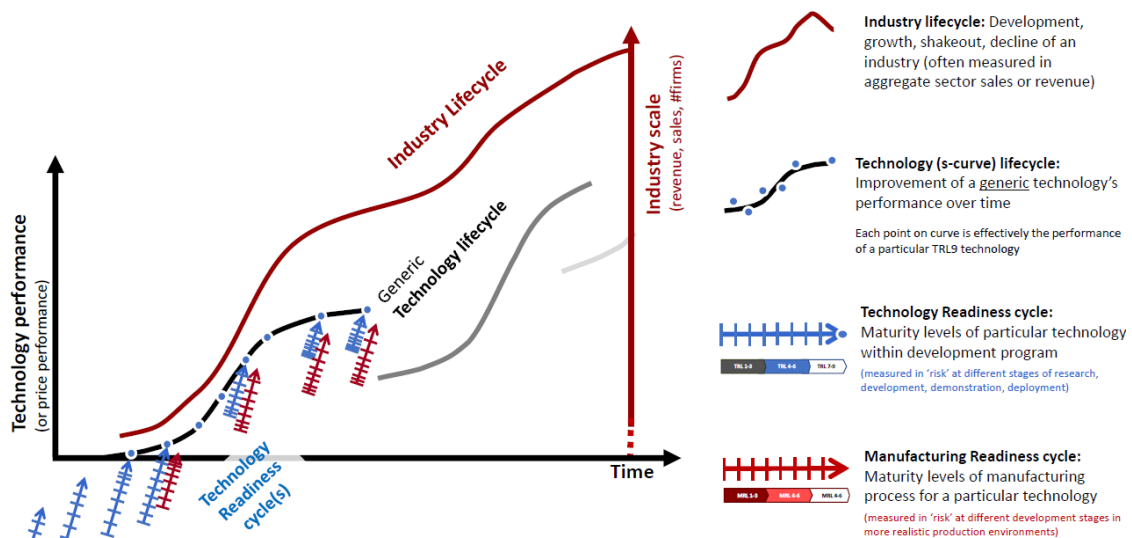
The sequencing of the analytical process is likely to be based on the 1) key objective set out, 2) stage of the emerging technology development, i.e., the lifecycle stage of the emerging technology being analysed related to 3) the state of policy and evidence available. For example, for an early stage emerging technology, just emerging from the science base and being explored by companies and governments, it is likely that following the current order of steps from 1 to 6 would be most useful, as not much evidence may be available yet and understanding the current and future system is necessary.

For a mid-stage emerging technology with some early applications that is already receiving significant government and private sector interest or investment, it is likely that several evidence gathering exercises have been undertaken already – often signalled in government policies. Therefore, evidence on capability and resource needs (Step 3) and key actors (Step 4) may already be available domestically or internationally, and therefore, enable narrowing down the number of technology pathways and related barriers and opportunities using roadmapping (Step 2).

For later stage emerging technologies where dominant designs in products and standards are emerging would shift emphasis on manufacturability, further narrowing technology pathways and concretising barriers and opportunities (Step 2). This could lead to clear policy recommendations (Step 5).

The strategic analysis needs to reflect the dynamic and evolving nature of emerging technologies, products and industries and related policies. Attention needs to be paid to different, nested and interdependent innovation lifecycles and readiness levels as shown in Figure 2.

Figure 2 Evolving and dynamic emerging technology lifecycles with implications for strategic analysis and its sequencing.



Step 1. Technology scope and system elements

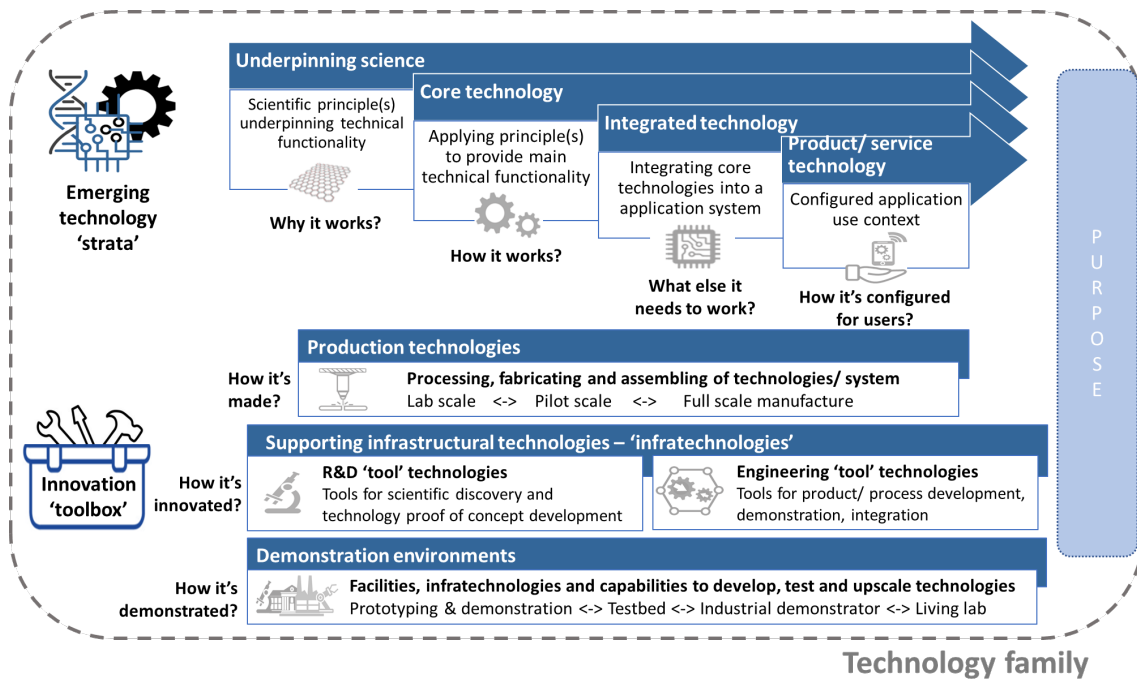
a. Define the technology scope of the strategic analysis

This can be at the highest level of technology classification (e.g., quantum technologies) or any level below (e.g., quantum sensors). This becomes the boundary object, which will be referred to as the *‘technology family’*¹ as it consists of several technologies.

b. Break down the complex technology family and identify its system elements

Identifying the different technologies that comprise the chosen technology family and the technologies that are or will be needed for their development and commercialisation can significantly improve the detail of analysis in later stages. To help guide this complexity, the *Technology ‘strata’ system framework*² can be used to provide a structure for analysis as shown in Figure 3.

Figure 3 Technology ‘strata’ system framework. Source: Döme & O’Sullivan, 2025.



In practice, the output of this exercise resembles a technology hierarchy and related definitions; and a checklist of different technologies that comprise the technology family required for development and commercialisation. This includes both technologies that are currently available and those that will be required in the future. This may require the identification of final products/ services or application markets, industries or sectors to enable foresight (also addressed in Step 2).

¹ Technology family is an umbrella term encompassing related and complementary technologies that share a common and evolving knowledge and technology base.

² Döme & O’Sullivan (2025). Technology ‘strata’ system framework (version 2, forthcoming). [Link to version 1.](#)

Step 2. Barriers and opportunities along technology pathways

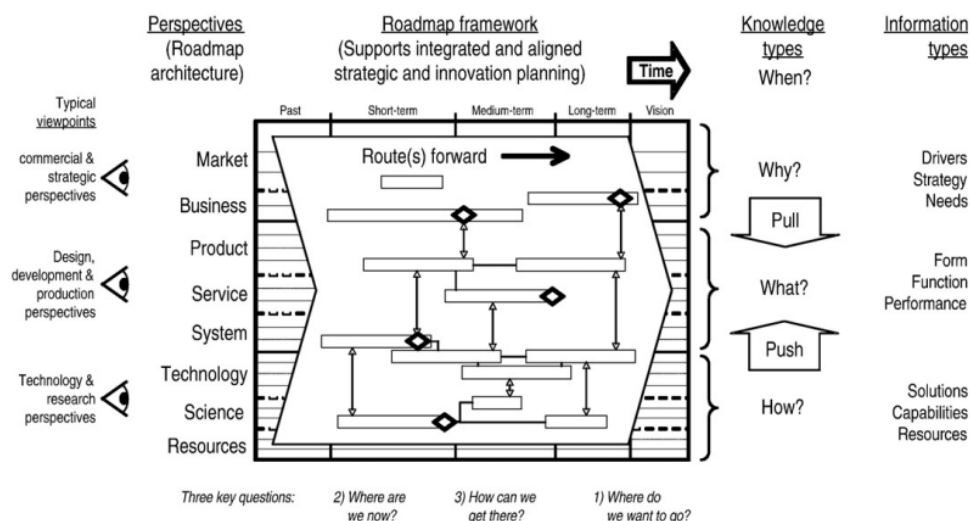
This step focuses on identifying key barriers and value adding opportunities that may arise along emerging technology pathways from technology to sectoral applications. This can be achieved through:

- a. Identifying and selecting sectoral applications
- b. Integrating technology system elements (from Step 1.b.) into a roadmapping structure (and adding other 'layers' that may be of interest given the objective of the analysis)
- c. Mapping technology pathways to sectoral application using roadmapping structure
- d. Identifying barriers and opportunities along technology pathways

Roadmapping, as a strategic visual canvas and a process, is a useful tool for this purpose.³ Its structure with time presented along its x-axis enables thinking in terms of pathways towards applications, while its layered structure along the y-axis enables breaking down complex strategic problems into multiple layers.⁴ It is used to integrate evidence and insights, draw out collective knowledge and imagination, and reduce information asymmetries and gaps.

Roadmapping layers can be easily adapted. For example, if used in combination with Step 1.b., it can easily incorporate the different technologies that comprise the technology family (e.g., core tech, production tech, tool tech) and map their combinations required for development and commercialisation of the emerging technology, providing an additional level of detail.

Figure 4 Schematic of a simplified roadmap. Source: Phaal & Muller, 2009.



³ European Commission JRC (2023). [Technology foresight for public funding of innovation: Methods and best practices](#). Tool 4, 5 and 6 could also be potentially used for identifying sectoral applications and enablers/inhibitors, respectively: [GO-Science \(2023\). An introductory systems thinking toolkit for civil servants](#).

⁴ Phaal & Muller (2009). [An architectural framework for roadmapping: Towards visual strategy](#).

Step 3. Capability and resource requirements

Key barriers and opportunities (e.g., identified in Step 2 or in another process/ analysis) can be overcome and enabled by understanding the **capabilities and resources that are required now and in the future (a.)**. This step focuses on identifying and decomposing these capabilities and resources in detail.

In terms of evidence, Steps 1 and 2 should provide significant technical context and detail for the capability and resource requirements, especially if they are based on technology expert workshops. They should also emerge as part of policy consultations or call for evidence – but this step is highly dependent on the level of detail. If neither is available, international sources of technical and/or policy evidence by other governments and organisations concerned with emerging technologies may be used.

Resources can be understood as tangible and intangible assets (co-)owned by actors that are combined into capabilities. Capabilities are complex combinations of resources working towards a desired outcome or strategy.⁵

Using *a structured checklist of resources and capabilities* can be useful,⁶ but it is necessary to consider their complex combinations and complementarities, to achieve a sufficient and necessary mix of resources and capabilities. Resources and capabilities can be disaggregated to lower levels.

Figure 5 Simplified checklist for resource and capability requirements (full version in Handbook).

<p>Technological (see Step 1.b. for more detail)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Science & technology research capability <input type="checkbox"/> Product development & engineering capability <input type="checkbox"/> Process development & manufacturing capability <input type="checkbox"/> Test & demonstration capability <input type="checkbox"/> Integration & system assembly capability <input type="checkbox"/> Patents, copyrights, trade secrets <p>Human</p> <ul style="list-style-type: none"> <input type="checkbox"/> Skilled workforce (researchers, technicians, engineers, systems engineers, etc.) <input type="checkbox"/> Skills & know-how <input type="checkbox"/> Workforce training <p>Organisational competences</p> <ul style="list-style-type: none"> <input type="checkbox"/> Organisational routines & processes <input type="checkbox"/> Capacity to integrate, build & reconfigure competences addressing rapidly changing environments 	<ul style="list-style-type: none"> <input type="checkbox"/> Network resources (capacity for communication & collaboration) <p>Infrastructural & physical</p> <ul style="list-style-type: none"> <input type="checkbox"/> Land <input type="checkbox"/> Critical minerals & materials <input type="checkbox"/> Energy availability & prices <input type="checkbox"/> Transportation <input type="checkbox"/> ICT <p>Governmental</p> <ul style="list-style-type: none"> <input type="checkbox"/> Patents, copyrights, trade secrets <input type="checkbox"/> Regulation & standards <input type="checkbox"/> Strategy <input type="checkbox"/> Data & information <input type="checkbox"/> Strategies for developing new capabilities <p>Financial</p> <p>...</p> <p>Behavioural & cultural</p> <p>...</p>
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⁵ Ramirez Garcia (2023). Opening the 'black box' of regional industrial-innovation systems.

⁶ Grant (2022). Contemporary strategy analysis (11th Ed.); Teece et al. (1997). Dynamic capabilities and strategic management.

Step 4. Actors

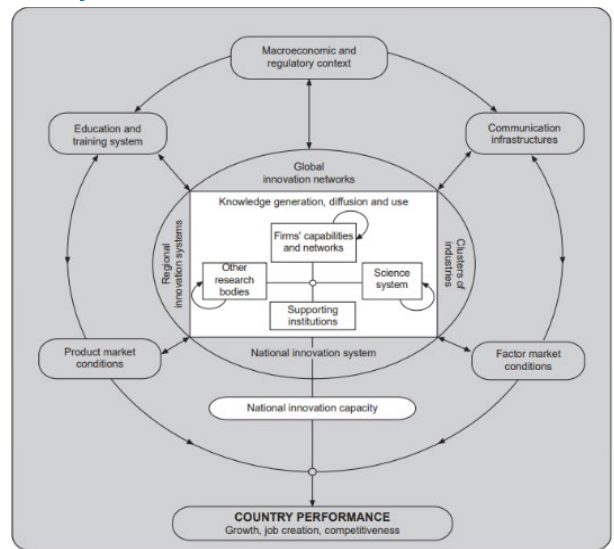
a. Identifying actors who have or could potentially have the capabilities and resources needed

*Innovation system frameworks*⁷ and *supply or value chain mapping*⁸ can be used to identify key actors in innovation and industrial systems.⁹ These tools require mostly qualitative understanding and exploration of actors and their networks, institutional frameworks, industrial structures, cultural conditions, and resources and capabilities.

Additional quantitative analyses can also be used to quantify and identify key actors, however, for these to be useful, they need to include detailed keyword searches:

- Bibliometric and patent analyses identifying key authors, patent applicants, universities, companies, countries, funders, topics
- Citation network analyses exploring strengths of relationships between actors
- Firm level analyses identifying key actors and their resources and capabilities

Figure 6 Actors and linkages in an innovation system embedded in the wider institutional framework. Source: OECD, 1999.



COSTA RICA IN THE MEDICAL DEVICES GLOBAL VALUE CHAIN, 2012

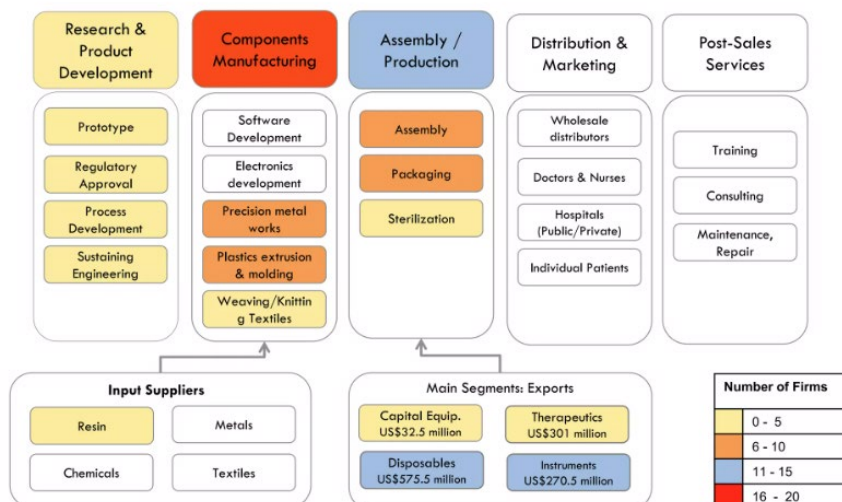


Figure 7 Example value chain map of the medical devices industry in Costa Rica in 2012. Source: Gereffi & Fernandez-Stark, 2016.

⁷ OECD (1999). *Managing National Innovation Systems*.

⁸ UNIDO (2009). *Value chain diagnostics for industrial development*; Gereffi & Fernandez-Stark (2016). *Global value chain analysis: A primer*.

⁹ Tool 1, 2 and 3 could also be used for identifying actors and their networks: [GO-Science \(2023\). An introductory systems thinking toolkit for civil servants.](#)

b. Assess the role of actors with potential capabilities and resources against the own-collaborate-access framework

Once actors with the necessary capabilities and resources — as well as those with the potential to develop them in the future — have been identified, the *own-collaborate-access framework*¹⁰ can be applied to guide strategic decisions about how to source these capabilities in the future.

This framework helps assess whether emerging capabilities should be met by building capabilities domestically, collaborating with partners, or securing access through other means, each posing different benefits, costs, and risks.

The choice is dependent on the level of ownership and control required from a supply chain and national economic security, and defence point of view, but also on the foreseeable potential to develop these required capabilities based on current capabilities, and their economic and public value (including spillovers into the ecosystem in the form of complementary capabilities).

Figure 8 Example use of the own-collaborate-access framework to assess capabilities.

	Own	Collaborate	Access
Actor 1			
-capability X now	X	X	
-capability X in 5 years		X	
-capability Y now	none	none	none
-capability Y in 2 years			X
-capability Y in 4 years		X	X

¹⁰ [HMG \(2021\). Integrated review of security, defence, development and foreign policy.](#)

Step 5. The role of government

a. Explore the role of government in addressing capability and resource needs

The role of government in emerging technology development and commercialisation is inevitable. Steps 2, 3 and 4 (or other analytical exercises with similar goals) should provide a more detailed context of key capability requirements and which of these need to be addressed by the government.

Literature on innovation policy suggests that the role of government can extend beyond correcting ‘traditional’ market failures. There are structural system and transformational system failures, which if addressed, help to shape the capacity of innovation actors to adapt, learn, and collaborate over time with a clearer sense of direction, demand, and opportunities for experimentation.¹¹ The checklist of failures below provides a framework for identifying where and how policy interventions may be needed across different types of failures.

Figure 9 Simplified checklist of failures that the government may need to consider. Source: Weber & Rohracher, 2012; BIS, 2014.



¹¹ [Weber & Rohracher \(2012\). Legitimizing research, technology and innovation policies for transformative change.](#); [BIS \(2014\). The case for public support of innovation.](#)

Step 6. International benchmarking

Each step of the emerging technology strategy process requires understanding whether data and evidence is universal globally (e.g., Steps 1-3 are most likely not to be country-specific) or whether it is country-specific (e.g., Steps 4-5 are most likely to be country-specific). Nevertheless, each step of the process requires consideration for both the domestic and the international context to ensure relevance, comparability and strategic positioning.

a. Benchmark internationally in each step, if not possible, undertake as a separate step here

Wherever possible, international benchmarking should be integrated throughout the process. If this is not feasible due to timing, resources, or availability of data, it can be consolidated into a dedicated benchmarking step at the end of the process.

The goal is to assess relative strengths, weaknesses, and positioning in a given emerging technology family, in comparison to international peers and frontrunners. To be useful, international benchmarking should go beyond high-level metrics and examine the emerging technology family at a sufficient level of detail whenever possible.

There is a need to understand how other countries are approaching technology definitions and classifications; how they are identifying key barriers and opportunities; what they think the key capabilities and resources required are; who their current and future key actors are; what policies and programmes they use and plan to use.

b. Take advantage of international analysis already available

As suggested in the introduction, for each step, scanning the international landscape can help to understand whether there is already existing evidence and analysis that can be used (e.g., technology definitions, technology classifications, technology roadmaps, etc.), specially produced by countries that are at a more advanced stage of strategic analysis. In many cases, significant efforts into evidence gathering have already been undertaken, lowering time and financial costs. Especially Steps 1-3 may benefit from non-country specific evidence, while Step 4-5 may benefit from the knowledge of policymakers undertaking significant consultation with key stakeholders.

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About the Project

The Policy Handbook on National Emerging Technology Strategising resulted from a collaboration between the Centre for Science, Technology & Innovation Policy (CSTI), Institute for Manufacturing, University of Cambridge; and the Directorate of Technologies, Growth & Security, Department for Science, Innovation & Technology (DSIT).

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